DON'T THROW OUT ALL OF YOUR BACKBOARDS: PEDIATRIC SPINAL IMMOBILIZATION

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Disclosures

- I have no significant financial disclosures

Disclaimers

- Out-of-hospital providers should follow local protocols at all times

"No, you can't list this as an 'indoor pool."

Objectives

- Review the epidemiology of pediatric spinal cord injury
- Compare pediatric and adult spinal injury
- Review the current literature on pediatric spinal immobilization
- Suggest a method for selective pediatric spinal immobilization

The Ultimate Goal?

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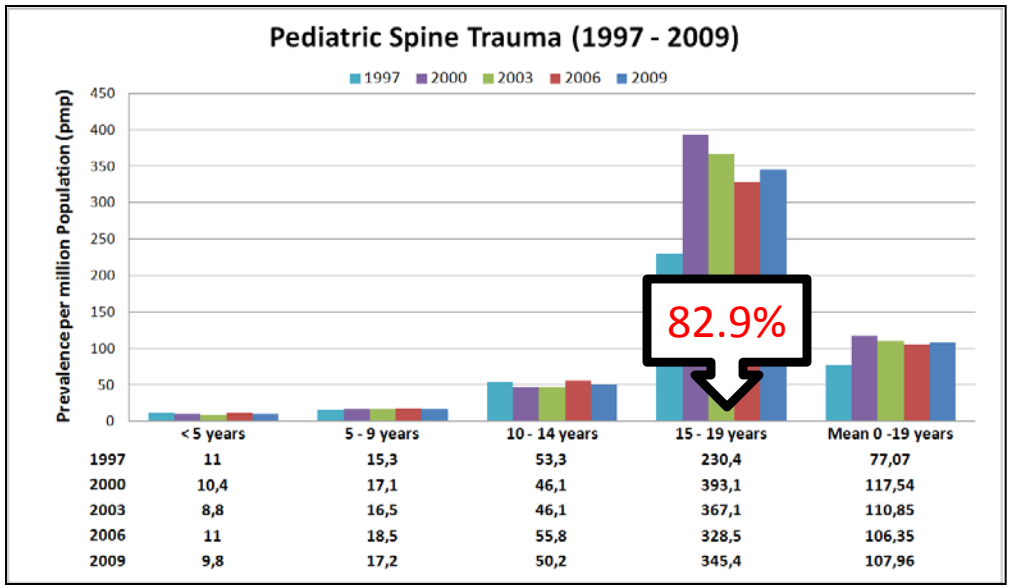
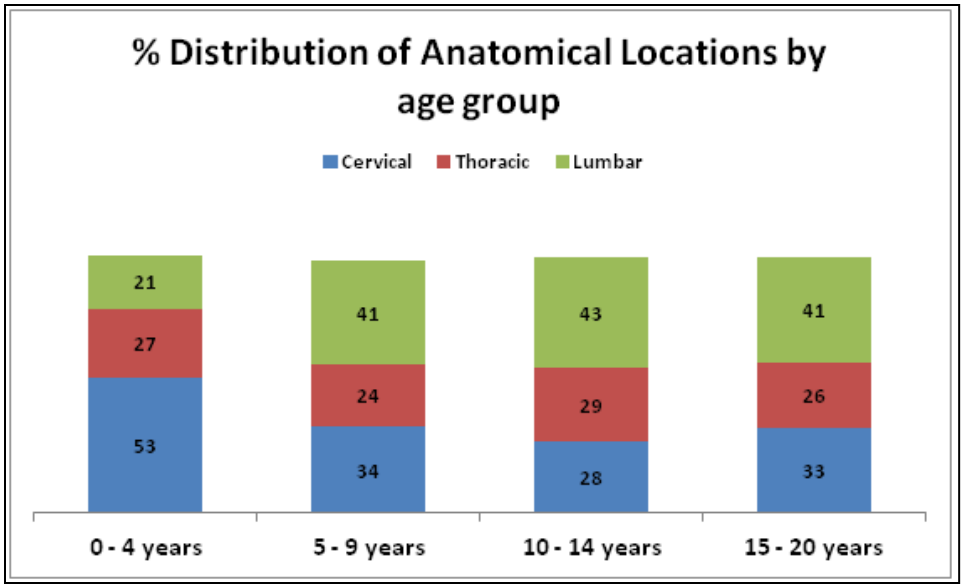
Mendoza-Lattes S et al. Pediatric spine trauma in the United States - Analysis of the HCUP Kids' Inpatient Database (KID) 1997 - 2009. Iowa Orthop J. 2015;35:135-9.



	< 5 years	5 - 9 years	10 - 14 years	15 - 19 years	Mean 0 -19 years
1997	11	15,3	53,3	230,4	77,07
2000	10,4	17,1	46,1	393,1	117,54
2003	8,8	16,5	46,1	367,1	110,85
2006	11	18,5	55,8	328,5	106,35
2009	9,8	17,2	50,2	345,4	107,96



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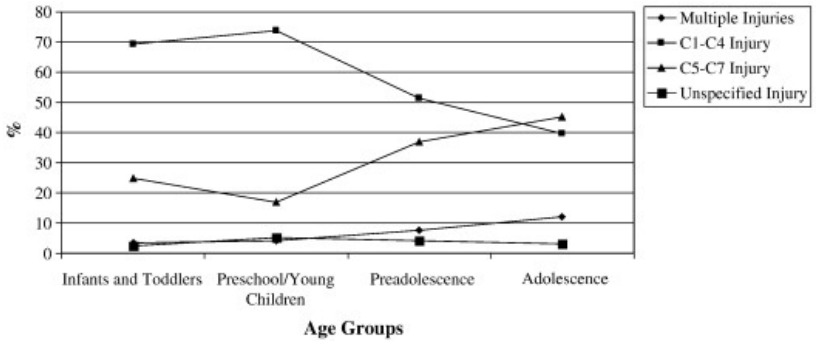
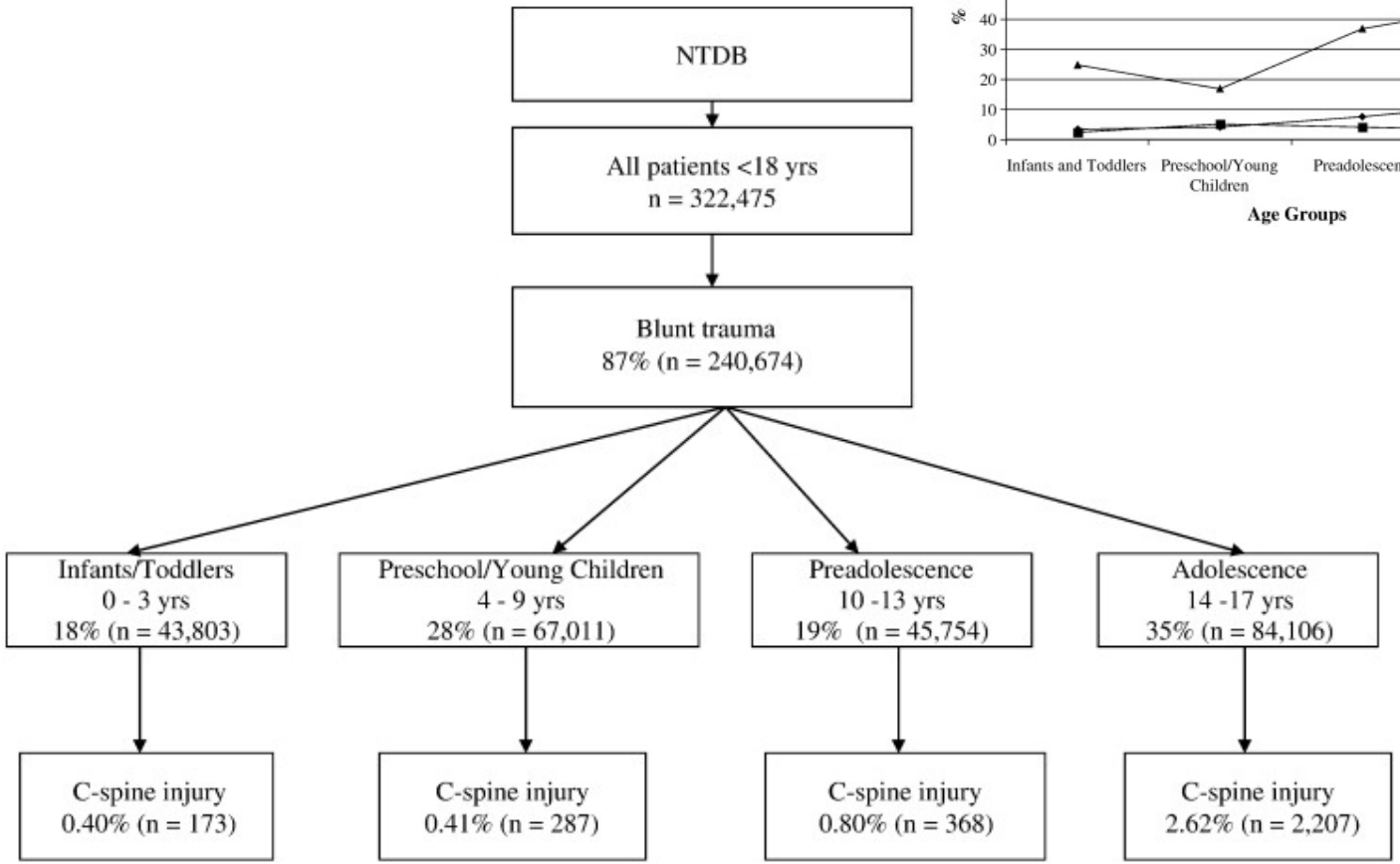
Distribution of Cervical Trauma by Age

Mohseni S et al. Effect of age on cervical spine injury in a pediatric population: a National Trauma Data Bank review. J Pediatr Surg. 2011;46:1771-1776.

A retrospective review of the National Trauma Data Bank for the period of January 2002 through December 2006





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Polk-Williams et al. Cervical spine injury in young children: a National Trauma Data Bank Review. J Pediatr Surg 2008;43:1718-1721

- January 2001 to December 2005
- Patients less than 3 years of age
- 95,654 cases of blunt trauma
  - 1,523 (1.59%) patients with spinal cord or column injury
    - 366 (0.38%) patients with a spinal cord injury (with or without column injury)
      - 184 patients with spinal cord and column injury
      - 182 patients with spinal cord and without column injury

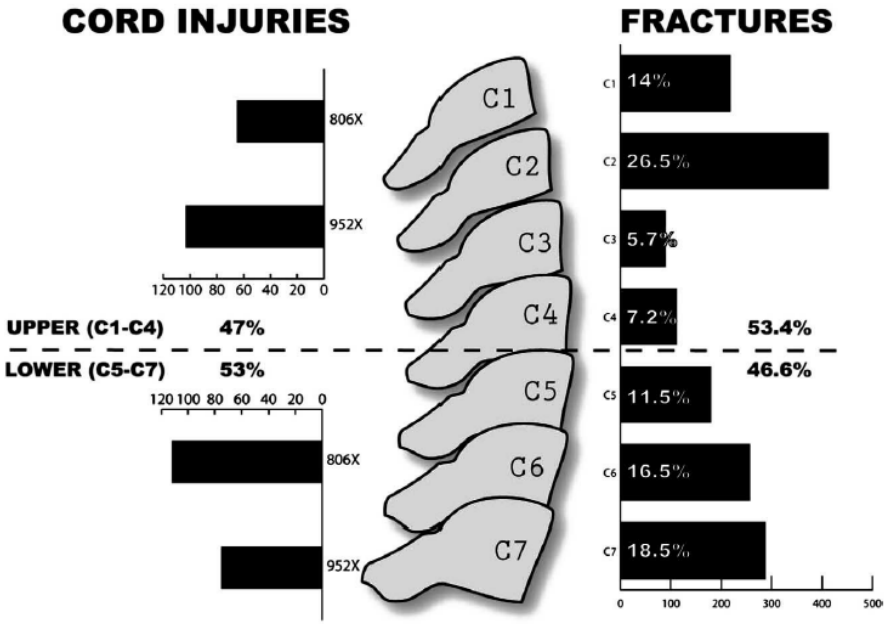


Fig. 1 Distribution of spinal cord and spinal column injuries by level (806× fracture of spinal column with cord injury, 952× spinal cord injury without evidence of bony injury.

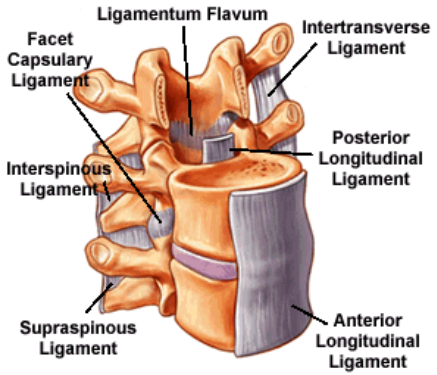
Table 3 Distribution of mechanism by injury [a]

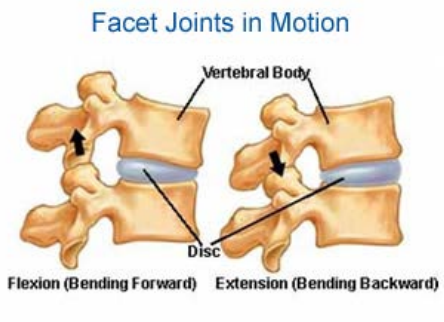
Mechanism	CSI (%)	Non-CSI (%)	*P*
MVC	65.73	32.44	<.01
Fall	14.58	26.59	<.01
Missing/unspecified	7.75	14.64	<.01
Transport, other	5.45	3.93	.003
Other	2.69	15.80	<.01
Struck by (assault)	2.36	4.92	<.01
Pedal cyclist	1.25	1.09	.569
Pedestrian	0.2	0.58	<.049

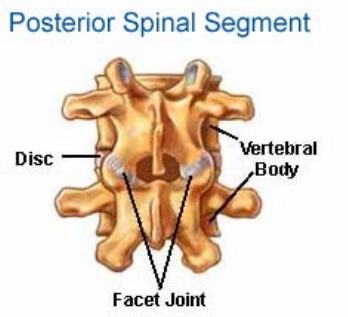
[a] Columns do not sum to 100% as list of mechanisms is incomplete.

Dickman C et al. Pediatric spinal trauma: Vertebral column and spinal cord injuries in children. Pediatr Neurosci. 1989;15:237-256

- Anatomic differences between pediatric and adult cervical spine are prominent until approximately 9 years of age
- Multiple vertebral ossification centers are present at birth
    - Epiphyses fuse at various ages
    - Most epiphyseal plates are fused by the age of 8
- Vertebral bodies in the pediatric spine are wedge-shaped
- Vertebrae in the pediatric spine are primarily cartilaginous
- Facets have a relatively horizontal orientation
    - Become more vertical and ossify between the ages of 7 and 10 years
    - Contribute little to vertebral column stability
- Head is large with respect to the neck and torso
- Paraspinous muscles are less developed, especially in the neonate
- The vertebral ligaments and soft tissues have greater elasticity than in adults
- All of these features combine to create
    - Hypermobility
    - Severe ligamentous injuries
    - Upper cervical spine injuries







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Leonard J et al. Potential adverse effects of spinal immobilization in children. Prehosp Emerg Care. 2012;16:513-518

Conducted at St. Louis Children's Hospital

July 2003 until August 2004

Convenience sample

285 pediatric patients

- 173 spine immobilization
- 112 not immobilized

Primary outcomes

- Level of pain on arrival to the ED
- Rate of cervical spine imaging

Secondary outcomes

- Length of stay in the ED
- Disposition from the ED

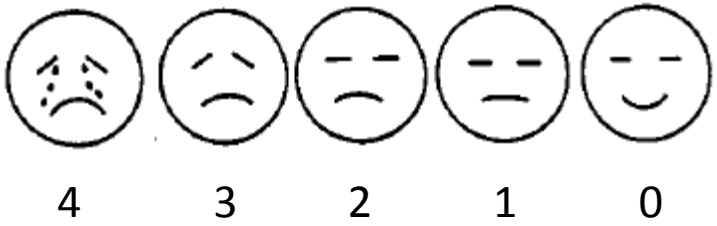

TABLE 2. Effects of Spinal Immobilization in Children

	Spine-Immobilized Prior to Evaluation ($n = 173$)	Not Spine-Immobilized but Met ACS Guidelines for Spinal Immobilization ($n = 112$)	Odds Ratio/ Hazard Ratio (95% CI)
Pain score—median (range)	3 (0–4)	2 (0–4)	2.2 (1.4–3.4)*
Cervical spine imaging, % (95% CI)†	56.6 (49.0–64.2)	13.4 (7.6–21.1)	8.2 (4.5–15.4)‡
ED length of stay—median (range), hours	2.8 (0.3–15.1)	2.8 (0.3–10.8)	0.96 (0.76–1.2)
ED disposition, % (95% CI)			
Home	58.4 (50.7–65.8)	85.7 (77.8–91.6)	*Reference*
Floor or transfer	31.8 (24.9–39.3)	11.6 (6.3–19.0)	4.0 (2.1–7.8)‡
ICU or OR	9.8 (5.8–15.3)	2.7 (0.6–7.6)	5.3 (1.5–19.0)*

*$p < 0.05$.
†Adjusted for Glasgow Coma Scale (GCS) score.
‡$p < 0.0001$.
ACS = American College of Surgeons; CI = confidence interval; ED = emergency department; ICU = intensive care unit; OR = odds ratio.

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Laham JL et al. Isolated head injuries versus multiple trauma in pediatric patients: Do the same indications for cervical spine evaluation apply. Pediatr Neurosurg. 1994;21:221-226

Retrospective chart review of 268 pediatric patients with isolated head injuries admitted to the intensive care unit (1985-1990)

Description	Low-risk group (n = 135)	High-risk group (n = 133)
Able to verbalize	135	4
Unable to verbalize	0	129
Preverbal (<2 years old)		55
Significant brain stem injury (table 1)		73
Inconsolable		1
Alcohol/substance abuse		0
Neck pain or tenderness	0	4
Cervical spine radiographs	121	108
Positive cervical radiographs	0	10

Characteristics	Low-risk group (n = 135)	High-risk group (n = 133)	p
Cervical spine injuries	0	10	
Age, years			>0.05
0–2	4	64	
3–5	38	18	
6–13	83	47	
14–19	10	4	
Sex			0.37
Male	100	92	
Female	35	41	
Mechanism of injury			>0.05
Motor vehicle accident	39	50	
Motor-pedestrian accident	37	27	
Fall	48	35	
Blunt trauma	11	7	
Gunshot wound	0	7	
Abuse	0	12	
Type of injury			0.06
Concussion	54	17	
Skull fracture	54	71	
Contusion	27	42	
Subarachnoid hemorrhage	16	37	
Subdural hematoma	19	30	
Extradural hematoma	13	12	
Intracranial hemorrhage	1	8	
Intraventricular hemorhage	2	6	
Herniation	0	5	
Cerebellar contusions	0	1	

The high-risk group had 23 times the likelihood of concurrent neck injury than the low-risk group (p=0.003; 95% CI 1.3-397.3)

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Viccellio P et al. A prospective multicenter study of cervical spine injury in children. Pediatrics. 2001; 108:e20

- Prospective observational study of 3,065 pediatric patients
- Looked at the NEXUS decision instrument in pediatrics
- Identified 603 low risk pediatric patients
    - None of the low risk patients had a documented cervical spine injury
- Sensitivity 100% (95% CI 87.8-100.00%)

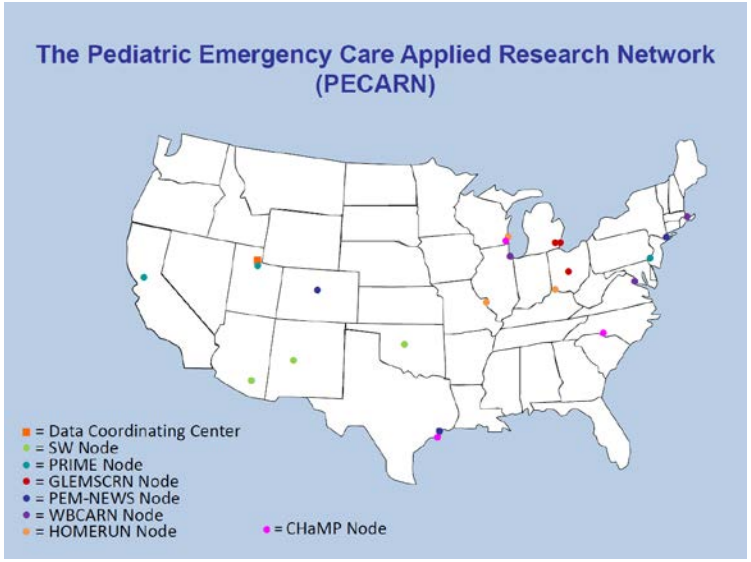
1. No posterior midline neck pain or tenderness
2. No focal neurological deficit
3. Normal level of alertness
4. No evidence of intoxication
5. No clinically apparent, painful distracting injury*

Limitations of the study

- Does not prove that NEXUS low-risk criteria can be applied to children with complete safety
- Sensitivity had a wide range due to small number of children with CSI
- Only 4 children with CSI younger than 9 years of age
    - Less confident about application of the NEXUS decision instrument to that group
- Appropriately sized study would require 80,000 children

Leonard JC et al. Factors associated with cervical spine injury in children after blunt trauma. Ann Emerg Med. 2011;58:145-155

- Retrospective case-control study (2000-2004)
- PECARN
- Age less than 16 years old



- Ran 3 different models
- High risk factors
  - Altered mental status
  - Focal neurologic deficit
  - Complaint of neck pain
  - Substantial injury to the torso
  - High-risk motor vehicle crash
    - Head-on collision, rollover, ejected from the vehicle, death in the same crash, or speed > 55 miles per hour
  - Diving

- Sensitivity (1 of 6 factors) was 92% (95% CI 89%-94%)
- Specificity (1 of 6 factors) was 35% (95%CI 32%-38%)

Pieretti-Vanmarcke R et al. Clinical clearance of the cervical spine in blunt trauma patients younger then 3 years: A multi-center study of the American Association for the Surgery of Trauma. J Trauma. 2009;67:543-550

- Retrospective chart review of 12,537 pediatric patient <36 months old (1995-2004)
- Split into 2 data sets
  - ⅔ to identify the clinical predictors of cervical spine injury to develop the algorithm
  - ⅓ to validate the algorithm
- Score of 0 or 1
  - Negative predictive value of 99.93% (95% CI 99.85-99.97)
  - Sensitivity of 92.9% (95%CI 85.1-97.3%)
  - Specificity of 69.9% (95CI 69.1-70.7%)

TABLE 3. Independent Predictors of Cervical Spine Injury

Variable	Odds Ratio	95% CI	*p*
GCS ≥14	12.5	5.0–31.6	<0.001
MVC	5.1	2.8–9.0	<0.001
$GCS_{EYE} = 1$	6.9	3.4–14.2	<0.001
Age >2 yr	2.2	1.2–4.0	<0.001

Based on best possible available evidence

If there is penetrating trauma to the spine → immobilize

What is the source of trauma?

- Substantial injury to the torso → immobilize
- Diving injury → immobilize
- High risk motor vehicle crash → immobilize
    - Head-on collision
    - Rollover
    - Ejected from the vehicle
    - Death in the same crash
    - Speed greater than 55 mph

If the pediatric patient is unable to verbalize → immobilize

- Preverbal (age less than 2 years old)
- Altered mental status (GCS less than 14)
- Inconsolable
- Alcohol or substance abuse

If the pediatric patient has neck pain or tenderness → immobilize

If the pediatric patient has focal neurologic deficit → immobilize

If the pediatric patient has a GCS_{EYS} equal to 1 → immobilize

THANK YOU GOOGLE IMAGES

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